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ABSTRACT

This paper argues that industrial innovation, which is essential for development, can be planned and managed at the national level as well as in industrial organizations, and that the time has come to bring the benefits of research and professional discussions in the area of innovation to education and training programs for industrial information officers. Five propositions are presented as a framework for discussion: (1) industrial information officers (IIO) support the company's management in its search for new opportunities and in the planning, operation, and evaluation of innovation projects; (2) the role of the IIO is that of a partnership in the entire process; (3) the IIO is responsible for the assessment of the organization's information needs, services, and resources, and for selecting the right time and opportunity to introduce changes; (4) a Master's level course and a series of continuing education seminars are needed to prepare industrial information officers with a wide knowledge base for the above three roles; and (5) to place this education program in the forefront of developments, it should have a research component with the objective of exploring the information requirements of innovation projects. A brief literature review is followed by definitions and interpretations of innovation in personal life, in organizations, and at the societal level. The paper then discusses the dimensions of the innovative activity; innovation transfer; managing information for innovation projects; educational considerations; a proposed scope for an educational program; preparation for new responsibilities; and a draft proposal for a course. A six-page list of references is included. (THC)

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THE MANAGEMENT OF INNOVATION AS AN INTEGRATING THEME IN THE CURRICULUM FOR INDUSTRIAL INFORMATION OFFICERS

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FID COMMITTEE ON INFORMATION FOR INDUSTRY

SEMINAR ON THE INTEGRATION OF EXTERNAL AND INTERNAL SOURCES OF INFORMATION IN THE INDUSTRIAL FIRM

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The Setting

Much has been written in recent years about the need for innovative concepts and techniques in technological development and industrial production. The literature cuts across several fields of research. There is renewed interest in the factors that enhance and motivate scientific creativity, and in ideas synthesized more than two decades ago (Kubie, 1962). New concerns have been added to existing themes. The transfer of technology in the form of products, processes or know-how to developing countries, has grown to an intense international issue in both economic and cultural terms (Baranson, 1981; Hope, 1982; Stewart, 1979). Nations in various stages of economic development seek to formulate strategies that stimulate domestic projects for innovation (Gerstenfeld and Wortzel, 1977). The tension between the private and social value of inventiveness has been studied in the context of economic theory (Hirshleifer, 1971) and in relation to the scientist's freedoms and limitations in research activity (Nelkin, 1984). Research, conferences and massive works have been devoted to the relationship between science, technological innovation and economic productivity (Asian Productivity Organization, 1984; Cetron and Goldhar, 1970; Commission of the European Communities, 1985). These themes have been converging into what has become known as the literature of innovation.

In this very broad and open-ended field, there are three domains that have direct bearing upon the education of information professionals: (1) innovation management, (2) information utilization, and (3) information resources management.

Institutions everywhere have constantly been put to test by economic and social stresses. Consequently, much attention has been given by researchers and policy makers to the management of economic and social intelligence (Perkins and Lawler, 1983; Twiss, 1980). Investigations into information systems which may support this management function have been widespread in a number of disciplines (Brinberg, 1984; Dror and Bnaya, 1984; Eveland, 1985; Stern, 1982; Train, 1984). This body of work has implications for industrial project management, which is often the vehicle for the innovation process. Thus, effective information systems and services in industry become an integral part of innovation management.

Another strain of research, generally referred to as user studies, originated in sociology, information science, economics and other disciplines to address the interface between information utilization and innovation (Crane, 1971). "What information do innovative people need or use" was a question implied in many information use studies. Some domains of this amorphous body of research have been organized, for example the area of technology utilization (Thompson, 1975).

Before the conceptual tools of the first two research fields -- innovation management and information utilization -- could have been integrated, a third approach has emerged: information resources management (IRM). Variously defined as professional practice, national-level policy or a new paradigm for systems analysis, IRM has the potential to become all of these things once it passes its formative phase. Reviewing the development, practices and literature of IRM, Levitan (1982, p. 227) called it both a management philosophy and a methodology. The concept

and its applications have been described in United States legislative and regulatory materials, in education programs, and in the literature of organizations. In basic terms, IRM means the management of all types of information as a national, organizational and individual resource.*

In summary, different directions in a voluminous literature are converging to support the argument that industrial innovation, essential for development, can be planned and managed at the national level as well as in industrial organizations. One of the fundamental steps in the process is the search for and the recognition of opportunities for the organization. This is only one example of the linking function of information.

Now is the time to bring the benefits of research and professional discussions to the educational front. All of us faced with the task of providing education and training programs for industrial information officers should ask how we can best integrate the theme of innovation with the information science curriculum at the Master's level.

Objectives

It is my intent with this paper to create an informal document as a basis of discussion in this seminar and perhaps also in some education programs and professional associations. This document is exploratory and its coverage of the innovation literature is merely indicative of some research directions. Good sources exist elsewhere for bibliographic coverage (U.S. National Sciences Foundation, 1983). I hope that the paper will stimulate reflection on the following five propositions:

* In a seminar held in 1983 September in Budapest, FID/II devoted considerable time to IRM.

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1. Information officers in industry support the company's management in its search for new opportunities and in the planning, operation, and evaluation of innovation projects.

2. The role of the industrial information officer is not one of passive support service but that of a partnership in the entire process.

3. The information officer is responsible for the assessment of the organization's information needs, services and resources and for the selection of the right time and of the right opportunity to introduce changes.

4. Since the management of innovation draws upon a wide knowledge base, a Master's level course and a series of continuing education seminars are needed to prepare industrial information officers for the above described three roles.

5. To put this education program into the front line of developments, it should have a research component with the objective to explore the information requirements of innovation projects.

Some Definitions and Interpretations

One of the problems of understanding the intellectual and administrative mechanisms that generate innovations is that, in spite of many years' work by international organizations and academic programs, basic definitions and tenets are still controversial.

Innovation in Personal Life. Because the drive to seek improvements in the human condition is part of everyday life, many people consider change, like creativity, a personal matter. In this context, the innovation process has been interpreted as self-help including the seeking and use of information. In this sense, innovation is indeed an intensely individual activity. Srinivasan (1977) proposed that in every society, people need "access to opportunities" in order to improve their lives and that levels of poverty could be measured by the lack of "access to opportunities." He suggested that unless a society provides organized information channels such as extension services, access to opportunities will remain a haphazard matter favoring the educated who are better equipped to "find out." These concepts are especially relevant to the improvement of industrial information services in the developing nations where much industrial activity takes the form of small entrepreneurship.

Equal access to education and information is one of the principles of technical assistance by international organizations. In some development projects, information is being seen not only as the necessary technical support to the project team, but also as one of the basic human needs of the recipient population, together with adequate food, shelter and clothing, essential services provided for the community,

and freely chosen employment (Hope, 1982; Pradervand, 1980; Streeten, 1979). And thus information literacy becomes one of the major goals of development aid.

Industrial innovation in developing countries may be brought forth by indigenous enterprises, small industry, tourism, artisan workshops, cooperatives and markets. Information exchanged by informal interactions may be more useful than formal systems in economies where there are a large number of small manufacturing and artisan firms (Page, 1979). In recognition of this reality, more and more technical aid providers, especially the private voluntary organizations (PVOs) use techniques of linking people and small local organizations into human resource networks in order to increase the motivation, the basic skills training and the new opportunities of people (Kouassivi, 1980).

Three observations about innovation projects in developing countries seem to be justified here.

First, studies on the effectiveness of technical aid have shown that neither the building of factories or housing developments nor the improvements in manufacturing processes will be accepted by local populations as changes introduced in their interest, unless local people will be involved in project-related decisions and planning (Uphoff, Cohen, Goldsmith, 1979).

Second, the diffusion of information creating opportunities and innovation in small enterprises heavily depends on kinship and social networks. Marketplaces, well known as viable points for information exchange, provide connections, sources of employment, partnerships, investment opportunities and other indirect benefits (Coletta, 1977).

Third, it is essential to remember that in poor countries the chances of the individual or of the small industry to bring about changes are often destroyed by major disasters such as drought and famine. Poverty traps people in unproductive conditions that sap their energy. Dawson (1978) saw the reluctance or inability of the poor to take risks as perhaps the worst barrier that stands in the way of innovations.

Innovation in Organizations. If the induced change process in personal life or small enterprises presents to the information professional a problem that can be understood only by close collaboration with information users, technological innovation in medium or large industry requires even more analytic and communication skills because of the large number of people — production workers, managers, engineers, researchers, marketers, etc., -- who are involved in a system. Organizational innovation depends on creative individuals and their activity in the organization (Rogers, 1983). These relationships in work have generated a voluminous research literature whose distillation, synthesis and study should be of great interest to information officers.

In this respect, innovation has been defined by the United States Office of Technology Assessment (1978, p. 4) as "the process by which problems are identified and solved, needs are met, materials are made available, and new concepts are added to society." The definition implies the interactions of ideas, people and technologies and views innovation as a collective problem-solving effort. Since the contribution of new concepts means intellectual production, this definition points to the relationship between industrial innovation and productivity.

In the industrial environment, innovation is usually understood to mean the introduction of a new process, product or technology. The Office of Technology Assessment (1978, p. 5) offers a further interpretation: "Innovation is more than discovery and theorizing, more than speculation and invention, and more than engineering design. For until the new know-how is incorporated into what is done, innovation has not occurred." We may assume that the essential activating element in the relationship between a new process and its application or between a new product and its use, is information. If that is the case, is the role of information as a link between innovation and productivity reflected in national policies?

After World War II, the formulation of national policies for the promotion of innovation and productivity has addressed mainly scientific research and technological development. Science and technology were seen as practically the sole means to rapid modernization in developing countries. The technological imbalance, which had been created by the larger capacity of industrial nations to support their scientific R & D, put an enormous strain on developing countries, urging them to improve their R & D capabilities. It was mainly in connection with technological innovation that national policies for the establishment of research centers, for the advanced education of the talented young abroad, and for the development of the physical infrastructures were made (Weiss, Jr., 1979).

As developing nations achieve various levels of industrial productivity, they find that economies can still be shaky and the distance between the well-to-do and poor populations still exists and in some cases it is increasing. They realize that industrialization and

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modernization are not solving all social problems. And since scientific and technical data alone do not explain the persistence of economic and social ills, governments are beginning to recognize the importance of economic, social and environmental data for decision making.

In recent years, delegates to international conferences have been stressing the need for socioeconomic data systems and relevant professional education in national development plans. International observers note that now national planners are referring to a new global imbalance between industrial and developing countries, the imbalance of information and data production and utilization (Brinberg, 1983; Glaeser, 1983).

This trend indicates that the links between innovation and productivity are multiple, and that they require data originating in research that spans many disciplines. Development economists urge that there is a need for new indicators of the quality of human life. Some planners value technology assessment data almost as much as data on technological growth.

Such changes in policies will require a reassessment of information systems planning. We have to remember that the state of social science data was characterized as having a "dispersed and nontransparent structure (Földi, 1983, p. 3). Improvements will be needed not only in social science data systems, but also in the information specialists's ability to design multidisciplinary data systems. The impact of such reassessment on industrial information officers and their professional education will be considerable.

Innovation at the Societal Level. Another kind of innovation affecting industrial information services is a national policy change. Examples are laws and regulations affecting export-import activities, raw materials, wages and prices, working conditions, environmental impact of industrial affluents, industrial safety, and so on. In several countries, for example in Canada, government subsidy of innovation projects aims to promote private sector investment in research and development (Tarazofsky, 1984). The result is usually a small and highly specialized information service that needs to be managed with full understanding of both governmental and industrial policies. Cooperation between industry and academic research centers is another strong trend which creates new patterns and relationships in information sharing (Eveland, 1985; Huddleston and Fenwick, 1983; Langfitt, 1983).

Many information officers make serious efforts to keep abreast of the laws, regulations, court decisions, standards, international treaties, conventions and conferences where resolutions are passed. Legal instruments and professional or trade standards often serve as unique information sources on new production or market trends. The quality of information services in industry is said to be strengthened when the information center's goals are coordinated with the goals of the organization and with the external influences upon the organization.

Dimensions of the Innovative Activity

The process of innovation or the introduction of something new in the organization's life is not as linear as one tends to think. Rather, the different aspects of the activity interact with each other, and they overlap to the extent that sometimes it is difficult to recognize the

beginning of an idea's travel through research laboratories, academic seminar rooms, government sponsored symposia, industrial R & D, experimental testing and implementation. It would be easier to design information systems in support of innovation if it were a more predictable process. As it is, information resources management must address and depend on intensive participation, communication, exchanges, and negotiations within the organization and in its external environment (Ciborra, 1983). Innovation projects with interdisciplinary R & D teams are likely to demand more complex communication processes than general staff interaction.

For a user-oriented design of information systems supporting innovation projects, an understanding of the innovation process itself would be useful for information officers. Studies of social scientists during more than three decades produced several models. All have raised significant issues concerning the relationship between science and technology policy and economic productivity. According to one theory, the process of innovation begins with basic or applied research whose results eventually lead to the development of a new device or a new process. This model, "science push" (a version of "technology push"), has been gradually overshadowed by the idea of "market pull." Numerous empirical studies suggest that the flow of invention moves from the identification of a need or problem to the generation of a new technology. In his groundbreaking work, Schmookler (1966) used patent statistics to interpret technological change and concluded that economic factors, such as market potential, greatly influenced the production of innovations. The term "social pull" indicates that studies demonstrating social needs

may generate experimentation with new problem-solving approaches (Agnew, 1980). As a consequence of research which rejected all the above described linear models, a school of thought is emerging which supports the existence of mixed patterns in the innovation process where economic factors, scientific research and technological or social invention interact (Freeman, 1979, pp. 213-215).

Innovation Transfer

The communication of innovative information from country to country is probably the most sensitive aspect of technology transfer. Transmission of innovation takes place when an organization or individual shares with or sells to persons in another country know-how which is either new or in the process of being developed. Information about any evidence that the new process or method had been pretested in the recipient country would be of great benefit to the industrial organization that anticipates the introduction of the innqvation. The literature refers to many cases in which production processes, management techniques or information systems that had been recommended by foreign consultants were inappropriate for the new user group. New technology might be too advanced or too obsolete for its intended users (Cusack, 1981; Lucas and Freedman, 1983). More than a few technical assistance projects have failed because of the assumption that a device or method designed for one environment will work in another culture (Stewart, 1979).

What can the information community learn from the experience of "false transfers" reflected in the development literature?

First, the large-scale innovation projects of the past have been attracting much criticism in developing countries. For example, a change-over to an online catalog in a library or a new education program normally require extensive institutional support in their new environment. The administrative structure, created by external specialists, cannot be readily integrated with the recipient culture (Dell, 1979, p. 306). Secondly, the psychological and technological gap between a foreign assistance team and local counterparts cannot always be closed. Unless continuous efforts are made for the involvement of indigenous colleagues in the planning and execution of innovation projects, the new techniques and tools might not be accepted by them for long-term use.

Managing Information for Innovation Projects

In the 1970s international organizations began to publish monographs and reports underscoring the need for analytic methods and other management skills in R & D and other innovation projects. The capacity to coordinate and utilize a large number of different information resources was identified as one of the attributes of the effective manager. Information resources management (IRM) might solve some problems in project management if its effects on the work of researchers and technologists could be better understood. The following questions represent the beginning of such probing that the proposed education program for industrial information officers should attempt.

Issue #1. How is new knowledge produced in industrial innovation projects? What do we know about the following ways:

- through an unexpected breakthrough or discovery that takes place during the course of a project pursuing other goals;
- through an unexpected discovery caused by chance rather than by a great measure of creativity and inventiveness;
- in the course of systematic, well planned, and steadily sustained R & D efforts, which are said to produce most of the industrial innovations (Sato and Suzawa, 1983);
- by risk-taking and changing the course of research or attempting something new without the benefit of long-range planning.

Issue #2. How does information relate to the innovation process?

We will recall that data, information and knowledge represent three interrelated but different concepts. Thus we can say that information (as well as data and knowledge) offer the following:

- input to the innovation process, providing support, stimulus, and continuity;
- output generated by the innovation process in the form of findings of research, know-how developed in the course of the work, and a link to the appliers of the research (Alvarez-Ossorio, 1984; Hill, 1985).

Issue #3. What types of information does the project require?

What are the relationships among the following kinds of information?

- data in science and technology;
- socioeconomic data and indicators for measurements such as indicators of the quality of work life, productivity and rate of invention;
- bibliographic and textual information;
- heuristics accumulated through problem-solving processes;

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- communications for the diffusion of innovation;
- personal, culturally determined, and unevaluated information passing through informal networks.

Other areas to be explored may be signaled by such questions as: How can we assess the impact of information on the innovation? What approaches can be used to optimize the impact of information on the innovation? In other words, how can one increase "good" information and eliminate "bad" information? What kind of education and training program [redacted] would be responsive to the needs of information officers in industry and flexible enough to be adapted to the requirements of each country?

Educational Aspects

There are at least two major kinds of information resources that need to be organized and managed: the more formal, structured, scientific/technical and the more informal, instinctive, organic sources of knowledge. The human response to the rapidly growing array of information resources is often a keen sense of futility. In the face of such information richness, the industrial researcher, technologist and project manager sense a maze of sometimes overlapping and sometimes badly lacking information channels. It seems that the successful transfer of information depends on many technological and administrative factors, but its effective utilization depends mainly on interactive relations of people. To achieve both the technological and the communication dimensions, several new programs have been designed in developing countries (Kaula, 1982; Mahamed, 1982; Mohamedali, 1983; Neelameghan and Picache, 1981). With respect to the problem of managing the resource

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called information, we have witnessed the taking off of programs in four directions: (1) teaching information-related courses to managers, (2) teaching general management principles and techniques to information professionals (Tees, 1984; Wasserman, 1984), (3) developing a completely new program for an integrated approach to information resources management, and (4) offering workshops on selected aspects of managing information.

With the rapid changes in the technological capabilities of industrial societies and the need of developing countries to close the technological gap, industrial organizations everywhere are under pressure to produce, to perform and to innovate. Information officers need to learn not only about the new technology but also about how to manage it for creative information transfer and how to maintain effective interpersonal communications. It seems imperative that information professionals prepare for a dual responsibility: providing support to the organization's innovation projects and making decisions about the continuous innovation and upgrading of information systems and services.

Scope of Proposed Program

A new approach to the understanding of the innovation transfer effort through research and curriculum revision should be concerned with (a) the conceptual clarification of innovation transfer and (b) with the techniques of field testing new procedures or tools before recommending their application.

Conceptually, the new curriculum should identify three interrelated activities: (1) hardware or process transfer, (2) information transfer

(data and documentation, standards and specifications, maintenance or process implementation guidelines, licenses, etc.), and (3) knowledge transfer (management skills, technical know-how, measurement criteria, evaluations of impact, training manuals, etc.).

As a remedy against the mismatch of need and innovation, adaptive field testing has been used as a project tool, allowing for experimentation with new approaches without drastic consequences. A program on innovation management should consider (a) administrative, (b) ethical, (c) technical, and (d) policy-related issues relevant to the field testing of an innovation proposed to be introduced in a developing country.

Administrative considerations may include the following: Should field testing be carried out by the staff of the innovation project or by outside consultants? Are local experts available? Who will carry the costs? How can the risks be assessed? What will be the consequences if the proposed innovation is not accepted for application? Is the documentation of the system or process adequate?

Probably the most difficult task is posed by the ethical issues which surround each change proposed for intercultural implementation. Have all ethical implications been considered? Who will be affected? How can the effects be communicated? What interests motivated the innovation? Will it provide equally distributed benefits or will it favor a few groups or individuals? Have the educational aspects been worked out so that all users or participants will have enough understanding of the innovation to make decisions about it?

Technical aspects which the new curriculum will have to address will be numerous. Will the introduction of the new technology or technique strain the existing communication infrastructure? Is there enough information about maintenance costs and methods? How much expertise will be needed to institutionalize the proposed change? Will technical training of users be feasible?

Some examples of policy-related issues will demonstrate their essential role in the transfer of innovations: Who owns the prototype process or new device? Should a license be purchased? What are the social controls that will affect the use of the innovation? Is it culturally and professionally relevant? Will the new application require modification? What should the appliers know about its long-range consequences?

An education program seeking to probe into the psychological and social dimensions of innovation will surely encounter the difficulty of covering such topics as creativity, motivation, and inventiveness in research and development (Twiss, 1980). While today many studies are exploring the relationship of these human phenomena to successful innovation and productivity, less attention has been given to the role of information. It will be up to the new curricula of information scientists and practitioners to meet this challenge.

Preparation for New Responsibilities

As partners in R & D projects, industrial information officers need to prepare for these and similar responsibilities in addition to the tasks of information management:

1. be aware of the state-of-the art of innovation research and literature;
2. assist in the identification and evaluation of new technical ideas;
3. be alert to new developments in copyright and patent legislation and other laws and regulations and standards affecting industry;
4. understand the goals of different projects within the organization, give information support to each and protect their proprietary information;
5. be knowledgeable about economic factors in information provision and use;
6. understand the use of computer and telecommunication technology and the need for data security in the context of projects which deal with sensitive proprietary information;
7. provide information counseling to researchers, engineers, project managers and other members of the team by identifying potential research issues, processes, methods and resources as needed;

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8. develop systems and procedures for information requirement assessment, current awareness service, decision support, database management, and evaluation and user education as appropriate to project management.

Draft Proposal for Course

The following outline of a Master's level course is suggested for discussion purposes. Its objectives are to (1) bring together concepts and techniques of fostering innovative activities at the organizational and national levels, (2) investigate the role of information professionals and systems in the innovation process, (3) review interdisciplinary research, institutions, conferences and publications worldwide that are pertinent to this area of knowledge.

The major benefit one may expect from the course would be its powerful potential to synthesize concepts of scientific and technological policies, economic development planning, cultural relevancy, creativity and productivity, social change and technology transfer.

The course should be offered in seminar style, to allow for discussions and individualized original projects by students. It could also be structured as a series of continuing education seminars for practicing industrial information officers and information policy makers. The outline does not intend to offer a "model" educational program, because each country, each cultural environment, would require changes and adaptations in both content and practical examples of applications.

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INFORMATION FOR INNOVATION

I Is innovation a management problem, an academic concept or a personal experience?

1. Can one "teach" anything about innovation?
   Examples of current approaches in different countries

2. Concepts, definitions and terminology

3. The management of research and development projects in industry

4. Cases of industrial innovation
   Small enterprises
   Innovation projects in large companies

5. The requirements of developing countries

II Information support for the innovation process

1. How to identify the role of information and data in project-related decisions

2. Review of theoretical models of the innovation process

3. How to bridge the gap between theory and practice

4. Professional ethics and information handling

III Information resources for R & D projects

Industrial library collection on innovation, bibliographic and numeric data, laboratory materials, research reports, technology forecasting tools, technology assessment tools, indicators, patents, licenses, standards and specifications, etc.

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IV The information professional as member of a project team

1. Introducing Information Resources Management (IRM)

2. Information services to support phases in research activities

3. Information services to facilitate research dissemination

4. Information services for technological applications

5. The information professional as catalyst and communicator in an organization

6. Information counseling, new interpretation and techniques of a professional role

V The innovation process at the national level

1. National development plans

2. Scientific, technological, economic and social policies

3. The importance of know-how at the entrepreneurial and small industry level

4. Technology transfer and information resources related to the process

5. The information professional's responsibility for and participation in infrastructure planning

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VI When and how to determine the need for innovation in information systems and services

1. The role of information science research

2. Financial assessment of changing information procedures

3. The impact on the staff and human relations

4. Managing the transition to an introduction of new information technology

5. Appropriateness of information system innovation in different countries

6. How to keep up-to-date on innovations in information science and services.

VII Critical evaluation of the literature on decision support systems, expert systems, and related developments.

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